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The Historical Development Of Arithmetic And Geometry And Its Implications

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THE HISTORICAL DEVELOPMENT OF ARITHMETIC AND GEOMETRY AND ITS IMPLICATIONS

EDWARDS

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RLE

To my husband and daughter

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CHAPTER I

INTRODUCTION

When did man begin to use mathematics? When was mathematics invented? The invention of this science has been customarily attributed to the Egyptians and Babylonians of the fourth or fifth millenium. But if we assume that mathematics was born when man began to have some understanding of numerical or geometrical relations, then mathematics is much older than those ancient people. The history of mathematics goes back to the primitive ethnic types of the Neolithic or perhaps paleolithic times.[1]

Man has always had some type of number sense, to the extent of recognizing the difference between *one* and *two*, or at least between *one* and *many*. Among the barbarous tribes whose languages have been studied, even in a cursory manner, none have ever been discovered which did not show some familiarity with the number concept.[2]

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[1] D. J. Struik, *A Concise History of Mathematics* (New York: Dover, 1948), p. 1.

[2] L. L. Conant, *The Number Concept* (New York: Macmillan Company, 1931), p. 1.

Little progress was made in understanding numerical values until the transition occurred from the mere gathering of food to its actual production, from hunting and fishing to agriculture. This happened not later than 6000 B. C. When this change occurred, problems of capacity took on new meaning. Volumes of granaries, both cylindrical and rectangular, were calculated in the Ahmes Papyrus.[3]

With this fundamental change, a revolution in which the passive attitude of man toward nature turned into an active one which marked the beginning of the New Stone Age, or the Neolithicum (20,000 years age).[4] Numerical terms then were qualitative rather than quantitative. Man made a distinction only between one (or better "a" - "a man" - rather than "one man") and two and many. When the number concept was extended larger numbers were first formed

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[3]F. W. Kokomoor, Mathematics In Human Affairs (New York: Prentice-Hall, Inc., 1942) p. 7.

[4]"Geological Chart," The Winston Dictionary (College Edition) p. 407.

by addition: 3 by adding 2 and 1; 4 by adding 2 and 2; 5 by adding 3 and 2.[5]

The development of crafts and of commerce stimulated this crystallization of the number concept. Numbers were arranged and grouped into larger units, usually by the use of the hand or of both hands, a natural procedure in trading. This led to numeration first with five,[6] later with ten as a base. Sometimes 20, the number of fingers and toes, was selected as a base.[7]

Numerical records were kept by means of placing groups of strokes on a stick, knots on a string, pebbles or shells arranged in heaps of fives-devices.

Evidence seems to show that the use of mathematics was begun in the Old Stone Age Civilization of hunters, fishermen, and early farmers. Mathematics was used or developed by man according to the necessities of his economic and social life. Although mathematics was influenced by magic, religion, and forms of government, as civilization advanced, so

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[5]Struik, op. cit., p. 3.

[6]D. E. Smith, History of Mathematics (Boston: Ginn and Company, 1923), p. 9.

[7]Conant, op. cit., p. 32.

did mathematics.[8]

Statement of the problem. The problem under consideration is an investigation of the development of arithmetic and geometry and its implications in Africa.

Purpose of the study. The objectives of this study are (1) to enrich the history of mathematics by introducing additional and/or new materials against which the teaching of mathematics could be made interesting to a larger number of individuals; and (2) to disclose some contributions of the Africans in the development of arithmetic and geometry and to determine, if possible, the progress of the development of mathematics by the Egyptians, Babylonians, and possibly the Greek, may have depended upon these contributions.

Scope and limitations. The supporting evidence for the hypothesis is based upon artifacts which have been discovered in Africa by anthropologists and archaeologists. The present study is limited to conjectures made from these findings. As evidence is uncovered by researchers, these conjectures may become facts.

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[8]Kokomoor, op. cit., p. 1.

For our present purpose this study is congined to the tribes of the Congo.

Organization of the study. In Chapter II, we discuss modern theories of the origins and development of man. Chapter III gives the African contributions to arithmetic and geometry. Chapter IV, the conclusion, is built upon my own finding from this study.

DEFINITION OF TERMS

Millennium. A period of a thousand years.

Neolithicum or Neolithic. The latter part of the Stone Age during which man developed polished stone tools and weapons and raised cattle.

Paleolithic. The period of the Stone Age between the eolithic and the neolithic.

Pleistocene Age. The first epoch of the Quaternary Period in the Cenozoic Era, characterized by the rise and recession of continental ice sheets and by the appearance of man.

Pliocene Period. The last epoch of the Tertiary Period in the Cenozoic Era, during which modern plants and animals developed.

Primitive. The beginning or the earliest times or ages.

Ethnic. Barbarous; uncivilized; savage.

Cursory. Hasty or careless; without close attention.

Anthropologist. A specialist in the study of the races, physical and mental characteristics, distribution, customs, and social relationships of mankind (especially) of primitive people.

Archaeologist. A specialist in the scientific study of the life and culture of ancient peoples, as by excavation of ancient artifacts.

Artifacts. Simple forms of primitive art.

Fossil. Any hardened remains or traces of animal life of some previous geological period, preserved in rock formations in the earth's crust.

Conjecture. An inference made from the present and incomplete evidence.

Antipodes. Any two places directly opposite each other on the earth.

Ahmes Papyrus. An ancient Egyptian mathematical document dating from around the Twelfth Dynasty (2000-1788 B.C,); it is in the British Museum.

Numeration System. Is formed when a certain set of symbols is used to represent numbers and different values assigned to a symbol depending upon

its position in a numeral or place value.

Base. The number it takes in any one place to make 1 in the next higher place.

Simple Grouping System. Some number b is selected for number base and symbols are adopted for 1, b, b^2, b^3, and so on. Then any number is expressed by using these symbols additively, each symbol being repeated the required number of times.

CHAPTER II

MODERN THEORIES ON THE ORIGINS AND DEVELOPMENT OF MAN

According to the findings of some anthropologists and paleontologists, man had its orgin in Africa. They agree that Africa is the cradle of the human race, that it witnessed man's first evolution from the anthropoid ape to Homo sapiens. Their findings of fossil bones in South Africa have compelled them to form this conclusion.[9]

English anthropologists W. E. Le Gros Clark and Doctor Robert Broom, Chief Paleontologist of the Transvaal Museum in Pretoria, have substantial evidence that man lived in South Africa in the Pliocene period, about seven million years ago.[10]

In South Africa a more recent finding of a fossil man Z i n j a n t h r o p u s (black man) in the deposits of the Lower Pleistocene Age, by L. S. B. Leakey, a social anthropologist is addi-

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9 Wilton M. Krogman, "The Man-apes of South Africa," Scientific American, Vol. 178, No. 5 (May, 1948), 16.

10 Ibid., p. 16.

tional available evidence that man originated in Africa.[11]

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[11] L. S. B. Leakey, The Progress and Evolution of Man in Africa (Fair Lawn: Oxford University Press, Inc., 1961), p. 2.

CHAPTER III

AFRICAN CONTRIBUTIONS TO ARITHMETIC AND GEOMETRY

Since we have established the fact that man probable has his origin in Africa, it is only logical that we look to Africa for the beginning of our numeration systems.

The earliest indications of man having a numeration system is that of the Ishango man in the Congo. Archaeological and geological evidence (artifacts) seem to prove that numeration systems were created by the Ishango man of the Congo some time between 9000 B.C. and 6500 B.C.[12]

The Ishango man was a true Homo sapiens, possibly Negroid, who represented the emergence in Africa of an indigenous Negro population from an older Paleolithic stock.[13]

The most fascinating and most suggestive artifact of the Ishango is the bone tool handle with a small fragment of quartz still fixed in a

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[12] Jean de Heinzelin, "Ishango," Scientific American, Established 1845, Vol. 206, No. 6 (June, 1962), 106.

[13] Ibid., p. 113.

narrow cavity at its head. Its shape and the sharp stone in its head suggest that it may have been used for engraving or tattooing, or even for writing of some kind. Even more interesting, are its markings: groups of notches arranged in three distinct columns. In one of the columns they are arranged in four groups composed of 11, 13, 17 and 19 individual notches. In the next, they are arranged in eight groups containing 3, 6, 4, 8, 10, 5, 5, and 7 notches. In the third, they are arranged in four groups of 11, 21, 19, and 9.

The groupings in each column are quite different from one another and each column contains internal relationship unlike those found in either of the others. In the first column, all are prime numbers in ascending order, and they are the only prime numbers between 10 and 20. The third column represents the digit 10 plus 1, 20 plus 1, 20 minus 1, and 10 minus 1. The middle column shows a less cohesive set of relations. Nevertheless, it, too, follows a pattern of a sort. The groups of three and six notches are fairly close together. Then there is a space, after which the four and eight appear also close together. Then, again, after a space, comes

the 10, after which are the two fives quite close. This arrangement strongly suggests appreciation of the concept of duplication, or multiplying by two.

These patterns indicate quite clearly that the Ishango man had a numeration system based on ten and a knowledge of duplication and of prime numbers.[14]

It is highly probable that this knowledge of the numerical system invented by the Ishango man spreaded northward along the Nile and westward to the southern border of the Sahara Desert. Artifacts found along these routes, dating from the mesolithic era, show that the culture of the Ishango man spreaded in these directions.[15]

Out of these Great Lakes Region of the Congo for many thousands of years Negro migrations streamed northward to Ethiopia and on to Egypt.[16]

An illustration is given here which typifies all practical methods of numeration for numerical records. This illustration was taken from the very

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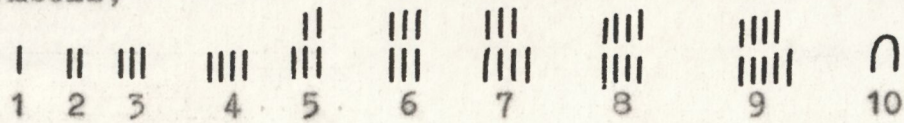
[14] Ibid., p. 110

[15] Ibid., p. 114.

[16] W. E. B. DuBois, The World and Africa (New York: Viking Press, 1947), p. 164.

antipodes of Madagascar.[17] Mom Cely, a southern Negro of unknown age, finds herself in debt to the storekeeper; and, unwilling to believe that the amount is as great as he represents, she proceeds to investigate the matter in her own peculiar way. She had "kept a tally of these purchases by means of a string, in which she tied commemorative knots." When her creditor "undertook to make the matter clear to Cely's comprehension, he had to proceed upon a system of her own devising. A small notch was cut in a smooth white stick for every dime she owed, and a large notch when the dimes amounted to a dollar; for every five dollars a string was tied in the fifth big notch, Cely keeping tally by the knots in her bit of twine; thus, when two strings were tied about the stick, the ten dollars were seen to be an indisputable fact." From this method of grouping and arranging numbers to the introduction of special symbols for these numbers was only a step and these symbols,



were used in Egypt about 3400 B. C.[18] at the begin-

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[17] Conant, op. cit., p. 9.

ning of written history, at the so-called dawn of civilization.[18]

As these people settled down to till the soil they developed mathematics, a practical device for solving their problems of living together.

Time was an important factor to the tenders of crops and flocks on the fertile plains of the Nile River. When to plant and when to harvest; when to expect the annual increase in the flocks; when to prepare for the certain overflow of the river -- these questions confronted them and they answered them with a mathematically devised calendar.

Therefore, well before 4000 B.C., the Egyptians had devised a calendar year (beginning about the time of the overflow of the Nile and containing 12 months of 30 days each, followed by five holidays at the end of the year). Careful astronomical observations and a relatively high degree of mathematical attainment were needed to devise a calendar so accurate that it was not improved for more than 4,500

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[18]"Numerals," Encyclopedia Britannica, XVI, 610.

years, when the Gregorian calendar (1582), presently used, was first put into operation.[19]

In the fertile valley of the Nile was the annual menace of flood waters, which, with all their wealth of soil deposits, swept away landmarks and added to or subtracted from the acreage bordering on the river itself. So, after the waters subsided, a resurvey of the land was needed for reestablishment of the boundary marks, not only for the benefit of the owners who wished to know what was theirs, but also for the purpose of taxation. For these needs more mathematics was called into service, i.e., geometry was invented.[20]

Units of linear and angular measure were needed. Triangles, rectangles, trapezoids, and circles appeared in the process of attack upon the problems encountered.

Stone began to be used for building in the Third Dynasty and in the Fourth Dynasty pyramids were built. The great Pyramids of Gizeh, "the greatest monument that any man ever had," contains

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[19] Kokomoor, op. cit., p. 2.

[20] Ibid., p. 3.

more stone than any other building ever erected and yet is one of the earliest structures of the world.[21]

The largest of all is the Pyramid of Cheaps. Its base is a 775 ft. square, and its altitude is about 493 ft. The height of it bears the same ratio to its perimeter at the base as the radius of a circle bears to its circumference.

Also erected in the Fourth Dynasty was the well-known status of the Sphinx with the lion's body and Negro head entirely carved in native rock.[22]

The pyramids, the Sphinx, together with many remains of temples, obelisks, and embankment constructions made for the obvious purpose of river control, all point to the early existence of a high degree of competence in arithmetic and geometric knowledge.[23]

The Egyptian hieroglyphics, a simple grouping system, is the earliest type of written

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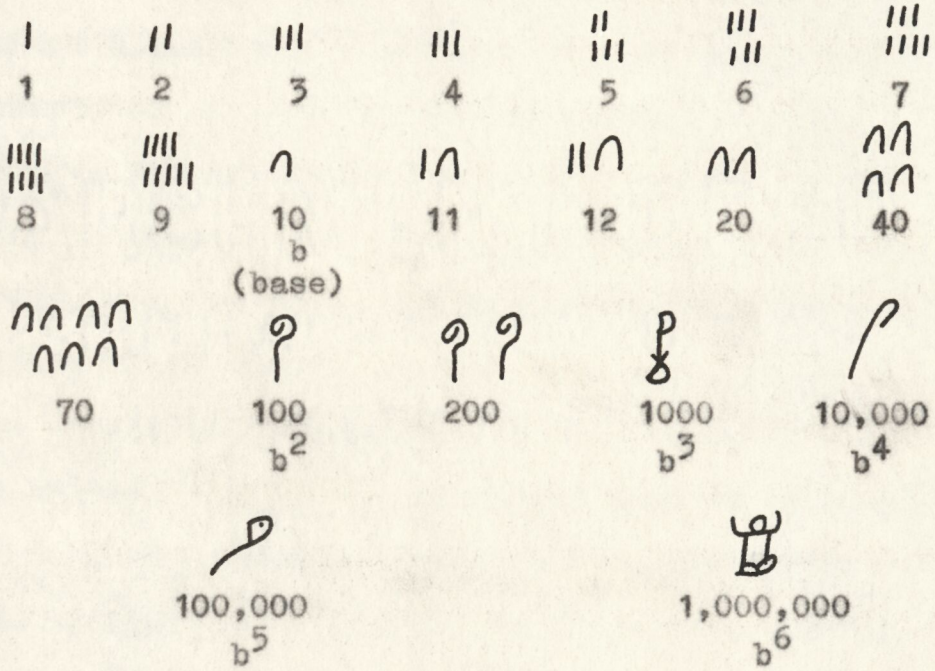
[21] DuBois, op. cit., p. 10.

[22] Ibid., p. 111.

[23] Kokomoor, op. cit., p. 7.

numeral system. Their number system is based in the scale of ten[24] although traces of other systems, based upon the scales of 5, 12, 20, and 60, are believed to have been discovered.[25] The ordinary form of hieroglysphic numerals are as follows:[26]



Any number is now expressed by using these symbols additively, each symbol being repeated the required number of times. Thus:

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[24]D. E. Smith, History of Mathematics, II (Boston: Ginn and Company, 1925), p. 46.

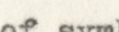
[25]F. Cajori, A History of Mathematics Notations, I (Chicago: Opening Court Publishing Company, 1928-29), p. 11.

[26]Smith, op. cit., p. 46.

112 equals

and

13,015 equals

The Egyptians recognized early that the ancient hieroglyphics script could be considerably abbreviated through the use of conventionalized symbols, and the result was a more cursive script known as hieratic.[27] This paleographic change resulted in a new basis for numeration in which a collection of symbol, such as  was replaced by a single mark or cipher, in this case,  . The number , similarly came to be simply . This scheme necessitates a distinctive mark or cipher for each of the first nine natural numbers for each of the first nine integral multiples of integral powers of ten. In this system of numeration, which might well be called a decimal cash register cipherization, any number less than a thousand would be represented by not more than three symbols: one for units, one for tens, and one for hundreds.

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[27] NCTM, The Mathematics Teacher, Vol. 52 (1959), p. 128.

Egyptian Mathematical Knowledge Spread Abroad

The culture of Egypt went out across the Mediterranean, lighting fires in Crete, inspiring Asia from Southern Arabia to Syria and Western Asia Minor.[28]

When persons wished to study science, art, government, or religion, they went to Egypt. The Greeks, inspired by Asia, turned toward Africa for learning. Greek mathematicians acknowledged the Egyptian priests to have been their teachers. The Romans in turn learned from Greece and Egypt.[29]

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[28] DuBois, op. cit., p. 122.

[29] Ibid., p. 105.

CHAPTER IV

CONCLUSION

The Congo Valley is probably the Africa whence all the other Africas have emerged; this is the hot heart of that mighty land which probably first gave birth and sustenance to human beings, and from which they crept, crawled, and marched to the conquest of the earth.

Every fact of history and anthropology proves that the Egyptians were an African people varying no more from other African people than groups like the Scandinavians vary from other Europeans, or groups like the Japanese from other Asiatics.[30]

The Egyptians affirmed that their civilization came out of the south, and modern research confirms this in many ways.[31]

From this study, we find that arithmetic and geometry were created by black men in their attempts to solve their daily problems. They

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[30] Ibid., p. 99.

[31] Ibid., p. 124.

could lay off angles, compute simple areas and volumes, add, subtract, multiply and divide, both whole numbers, and fractions; and solve numerous problems of wide variety.

The numeration system based on ten seems to have originated in the Congo and spreaded to Egypt, revised in India and carried to Europe by the Moors.

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